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TC/TG/TRG MINUTES COVER SHEET

(Minutes of all meetings are to be distributed to all persons listed below within 60 days following the meeting.)

TC/TG/TRG NO. TG4.SBS **DATE: 13 SEPTEMBER 96**

TC/TG/TRG TITLE: Computer Applications

DATE OF MEETING: 23 June 96 **LOCATION: San Antonio**

Voting Members Present	Appt	Voting Members Absent	Appt	Non-Voting Members and Visitors Present	Continued
George Kelly	96-98	Arthur Dexter (int'l member)	96-00	John Seem (CM)	Gene Strehlow
John Mitchell	96-00	Carol Lomonaco	96-99	John House (CM)	Clay Nesler
Les Norford	96-98	Mark Bailey	96-00	Nebil Ben-Aissa (CM)	Rad Ganesh
Jim Braun	96-00	Ira Goldschmidt	96-97	David Kahn (CM)	Alan Hill
Philip Haves (int'l member)	96-00	Larry Henson	96-98	Tim Ruchti (CM)	Rich Hackner
Steve Blanc	96-99	Michael Kinter-Meyer	96-97	Jim Winston (CM)	Osman Ahmed
Barry Bridges	96-97	Patrick O'Neill	96-99	Cher Nicastro	Harsha Dabholkar
Ron Kammerud	96-99	Peter Simmonds	96-97	Winston Hetherington	Jim Butler
Doug Nordham	96-98	David Underwood	96-98	William Savery	Mike Brambley
				Ofer Pittel	Hank Harrington
				Larry Uebele	Patrick Sheridan
				Bob Zamojcin	Gideon Shavit
				Terry Townsend	Mike Kovacs
				Verle Williams	Mike DeNamur
				Kathie Radke	J. Carlos Haiad
				Jim Coogan	Jean Lebrun

DISTRIBUTION:

Above list

TAC CHAIRPERSON: James M. Porter
TAC SECTION HEAD: Terry E. Townsend

LIAISONS
Program: Larry O. Degelman
Research: Carl F. Spreich
Standards: Richard L. Beck

MANAGER OF TECHNICAL SERVICES: Claire B. Ramspeck
MANAGER OF RESEARCH: William W. Seaton
MANAGER OF STANDARDS: Jim L. Heldenbrand

ASHRAE TC ACTIVITIES SHEET

DATE: 13 September 96

TG NO. TG4.SBS **TC TITLE: Smart Building Systems**
CHAIR: G. Kelly **VICE CHAIR: J. Mitchell**

TG Meeting Schedule

Location, past 12 mo.	Date	Location, next 12 mo.	Date
San Antonio	6/23/95	Philadelphia	1/26/97
		Boston	6/97

TG Subcommittees

Subcommittee	Chair
Fault Detection/Diagnosis	J. Seem
Applications	J. House
Utility/Building Interface	S. Blanc
Research	J. Braun
Program	C. Lomonaco

Research Projects - none

Long Range Research Plan

Rank	Title	W/S Written	Approval	To R&T
1	Integrated Building Services - Performance and Performance Measures	No	No	No
2	Methods for the Real-Time Detection and Diagnosis of Centrifugal Chiller Faults	No	No	No
3	Distributed and Hierarchical Fault Detection and Diagnosis of HVAC Systems	No	No	No
4	Optimizing EMCS Architecture in BACnet Speaking Systems	No	No	No
5	Utility/EMCS Communication Protocol Requirements	No	No	No

Handbook Responsibilities - none

Standards Activities - none

Technical Papers from Sponsored Research - none

TG Sponsored Symposia (past 3 years, present, planned)

Title	When Planned
HVAC System Fault Detection And Diagnosis (Kelly)	Philadelphia, 1/97

TG Sponsored Seminars (past 3 years, present, planned)

Title	When Planned
Utility/Building Interface (Blanc)	Boston, 6/97
Automated Response To Real Time Pricing (Kammerud)	Boston, 6/97

TG Sponsored Forums (past 3 years, present, planned)

Title	**When Planned**
Exactly What Do Smart Buildings Mean Today? (Kelly and Newman)	Philadelphia, 1/97
What Are The Priorities For On-Line HVAC Fault Detection And Diagnosis? (Haves)	Philadelphia, 1/97
Can Buildings Be An Interactive Site? (Bridges)	Boston, 6/97

Journal Publications (past 3 years, present, planned)

Title	**When published**
None	

Submitted by: **<u>Les Norford-- TC 1.5 Secretary</u>**

TG4.SBS Minutes
Sunday, June 23, 1996 -- San Antonio

Chairman George Kelly called the meeting to order at 5:00 p.m.

Voting Members Present: Kelly, Mitchell, Norford, Braun, Haves, Blanc, Bridges, Kammerud, Nordham.

Chair's Report --George Kelly

Kelly made minor changes to the agenda (Attachment A), reversing the reports of the Smart Building Systems (SBS) Applications and the Fault Detection and Diagnosis (FDD) Subcommittees. Those attending then introduced themselves. Subcommittee meetings will be conducted during this inaugural meeting of the TG, but will shift to separate time slots in the future, which will be requested to be immediately before the TG meeting. Kelly read the scope of the TG (Attachment B), as put forward to R&T. He noted that some fuzziness in the TG's mission is acceptable, with in an overall goal of improving the functionality of building systems and determining the proper level of human intervention in building operation.

Kelly invited those present to join the three technical subcommittees: FDD, SBS Applications, and Utility/Building Interface, with the following response:

Subcommittee	Members
FDD	Seem, Haves, Winston, Mitchell, Uebele, Lebrun
SBS Applications	House, Strehlow, Shavit, Kahn, Ruchti, PIttel, Bridges, Ahmed
Utility/Building Interface	Blanc, Nordham, Haiad, Kammerud, Hackner, Norford, Kinter-Meyer (after meeting)

Kelly urged every member to become active in at least one subcommittee. Members who are not active and who miss two consecutive meetings may be dropped. These subcommittees will feed research and program ideas to the Research and Program Subcommittees, each of which will be staffed by a single person (Braun and Lomonaco).

Subcommittee Reports

SBS Applications -John House

House, Blanc and Kelly commented on the range of applications that might concern this subcommittee, including demonstrations of FDD technologies and BACnet. It was noted that the GSA's Philip Burton office building in San Francisco is a BACnet demonstration site. This 1.4 million square foot building will receive other upgrades as well, including automated lighting and an EMS with chiller controls. Possible ASHRAE roles in this project could include documentation of the integration of services and improved functionality.

A new IEA Annex concerning FDD applications has been formed. Annex 34, "Computer-Aided Evaluation of HVAC System Performance: the Practical Application of Fault Detection and Diagnosis Techniques in Real Buildings," will have its first meeting at the Swedish National Testing and Research Institute, Boras, Sweden, September 16-17, 1996. For more information, contact Svein Ruud (46-33-165514 (voice) 46-33-131979 (fax)). This Annex is the follow-up to IEA Annex 25, Real-Time Simulation of HVAC Systems for Building Optimization, Fault Detection and Diagnosis.

Public Works of Canada is looking toward a FDD demo in 1997, which may include such integrated services as fire protection and elevator control.

Ben-Aissa asked whether the subcommittee's work would include industrial sites, with process control integrated with HVAC and life services.

Program - see below.

Fault Detection and Diagnosis

Seem reviewed the work of IEA Annex 25, which included simulations and lab tests of FDD methods. Haves provided background information about IEA and its Annexes. Seem described the functioning of HVAC alarms now in use in buildings: tight alarms often trigger and are often ignored, while wide alarms give no feedback, which comes instead from uncomfortable occupants.

Seem listed three areas of work: performance monitoring - deriving from measurements appropriate performance indices that permit comparison across units; establishing fault detection thresholds; and identifying fault diagnostics.

Others briefly described recent FDD work. House has detected and diagnosed hard faults (as distinguished from degradation faults) in VAV ventilation systems, using an artificial neural network (ANN). Seem noted that FDD procedures can work at the level of a local-loop controller, an entire air handling unit (AHU), or a building as a whole. Haves developed an FDD method based on physical models and applied this methodology to an AHU. He is about to start a collaborative project with two universities and control companies to test FDD techniques in real buildings. Norford described his work to detect electrical loads via high-speed analysis from a central location rather than more expensive sub metering. Lebrun's work at the European Community's headquarters building in Brussels was noted and was also described in an ASHRAE seminar at San Antonio. Lebrun is also interested in such laboratory studies as determining compressor performance. Braun has focused on roof-top vapor-compression equipment, using temperature measurements to diagnose five faults, including refrigeration leakage and heat-exchanger fouling. He uses a model for normal behavior, detects differences between expected and measured performance (residuals), and applies a rule-based diagnosis.

Kelly concluded that there is a need to integrate multiple FDD methods and to determine what information is best conveyed to a building operator. Blanc endorsed integration, including two-way connection of tenants and buildings and utilities and buildings. Lebrun saw a need to determine what information is needed and how to manage it. Ben-Aissa stated that it may be better to tell an operator what to do, rather than just inform him or her of a problem and Blanc reiterated the continuing role of building operators, noting that tools, not people, need to be replaced.

Utility/Building Interface

Blanc offered to chair a seminar in Philadelphia (changed to Boston after the meeting)on various issues related to the utility/building interface. Architectures for utility-customer communication are the subject of considerable EPRI interest and exploration on a proprietary basis between utilities and such firms as Novell and Microsoft. Consequences of deregulation of the electric utilities can be posed as a series of questions: Who will deliver services? What services will utility customers want? Will deregulated utilities be able to offer services? What data should customer and utility gather about a building, so that customer can shop and utility can offer?

Blanc outlined the following topics for a seminar: 1. Survey of RTP and future rates. Where will this mutate? Could have 3-4 vendors serving an aggregate of customers. 2. Deregulation and you. Who is taking the lead? What about the UK system? 3. What kind of services do customers want? For one, when does power come back after an outage? 4. What role for unregulated and regulated utilities. Utility futures now being traded? 5. What will customers do? Norford and Nordham volunteered to prepare talks.

Nordham noted that a thermal energy storage system is a crude response to ToU rates. What happens when prices change every 15 minutes? How will HVAC designer plan for this? Haiad noted that rates are now in place with variation from cents to dollars.

Haiad broached the concept of real-time information network to provide information to building owners and operators. He will consider a seminar in a year.

Kammerud suggested a seminar on RTP control, now scheduled for Boston.

Program

Program ideas were gleaned from technical subcommittee reports. In the absence of the program subcommittee chair, each volunteer for chairing a seminar or symposium or monitoring a forum will do his/her own program package, respecting the August 12 deadline for programs at Philadelphia. Forums in the next 2-3 meetings will help define the mission for this TG, which will extend beyond the optimization work of TC 4.6. These sessions will solicit participation of building operators.

The following topics were proposed:

<u>Philadelphia January 25-29, 1997</u>

1. Joint forum with 1.4, 1.5 and 4.6. Kelly will chair with Mike Newman. “Exactly what do smart buildings mean today?”

2. Forum on FDD, soliciting input from operators and owners concerning their priorities. How do they rank faults? Haves will chair.

3. Symposium on FDD, "HVAC System Fault Detection and Diagnosis,' which Kelly is putting together with papers that document results from IEA Annex 25.

4. Seminar or possibly symposium on intelligent sensors, sponsored by TC 1.4. Ben-Aissa asked if TG4.SBS would co-sponsor.

<u>Boston</u>

1. Forum. Does a smart building become a Web site? Can occupants kick in their own vote, in interactive buildings? Bridges will chair.

2. Seminar on utility/building interface, chaired by Blanc. (This was changed from Philadelphia to Boston after the meeting.)

3. Seminar on RTP control, chaired by Kammerud.

<u>Research</u>

Kelly and Braun will prepare a long-range research plan for TG4.SBS. Because the research plan must be received by the Manager of Research by August, it will be submitted to voting TG members for a vote via email and fax. The plan will consist of a ranked set of one-page research summaries. Note: The research plan as subsequently approved by a vote of 17-0-0 (18) (chair voting) is included as Attachment C.

<u>New Business</u>

After some discussion, it was decided to continue to hold TG meetings on Sunday evening. Kelly will reserve a time block sufficient for subcommittee meetings to be held before the main TG meeting.

<u>Adjourn</u>

The meeting was adjourned at 6:54 p.m.

TG4.SBS Meeting Agenda (Attachment A)

Location: Conference Room 5, Marriott River Center

Date: Sunday, June 23, 1996

Time: 5:00 - 7:00 pm

1. Roll call and introductions
2. Announcements and Procedures
3. Discussion of Scope and Activities
4. Subcommittee Membership
    - Fault Detection and Diagnostics Subcommittee (FDD Subcommittee)
    - SBS Applications Subcommittee (SBS Appl. Subcommittee)
    - Utilities/ Buildings Interfacing Subcommittee (Util/Bldg Subcommittee)
    - Research Subcommittee
    - Program Subcommittee
5. Meeting of the FDD Subcommittee
    - IEA Annex 25 and a possible New Annex
    - Other FDD research activities
    - Work Statements and Program plans
6. Meeting of the SBS Appl. Subcommittee
    - Philip Burton Office Building
    - Other possible demonstration sites
    - Work Statements and Program plans
7. Meeting of the Util/Bldg. Subcommittee
    - Real time pricing
    - Deregulation
    - Real time information Networks (RINs)
    - ASHRAE s role
    - Work Statements and Program plans
8. Meeting of the Research Subcommittee
    - Long Range Research Plan
    - Work Statements
9. Meeting of the Program Subcommittee
    - Plan for Philadelphia
    - Plan for Boston
    - Plans for future meetings
10. Additional new business

TG4.SBS Mission Statement (Attachment B)

Title: Task Group on Smart Buildings Systems (SBS)

Scope: The Task Group on Smart Building Systems is concerned with the performance and interactions of smart building systems, the impact of smart systems on the total building performance, methods for achieving more intelligent control and operation of building processes, interactions of smart buildings with utilities, and documentation of the benefits of smart buildings and smart building systems as they relate to energy consumption, cost of operation, maintenance, occupant comfort, building commissioning, operations, and the impact of SBSBS on utilities and natural resources.

Activities to Fulfill the Scope:

Research: To evaluate the application of BACnet and, where appropriate, other communication protocols to smart buildings and to document their impact on building system functionality and performance. (NOTE: The TG will not be involved with the development of protocol standards or with evaluating compliance to such standards.)

To develop and demonstrate the application of system identification, fault detection and diagnostic methods to building HVAC systems and equipment.

To evaluate methods for real time monitoring and validation of building system performance.

To determine the needs and requirements for Utility-Building Management System (BMS) communication and to study its application in real buildings. Issues to be addressed include real time pricing and purchasing ("wheeling") of energy, and performance related topics, such as security, safety, reliability, and confidentiality.

To evaluate and document the benefits of smart buildings and smart building systems in demonstration projects involving building owners and managers, utilities, control companies, and energy service companies.

Programs: To report on research and applications relating to smart buildings and building systems and to describe and clarify key factors in the TG's scope.

Handbook: To describe the design, operation, performance and benefits of smart buildings and smart building systems.

Need for the Task Group:

This Task Group is concerned with a new area of technology that is only just becoming available, yet one which, within a few years, should have a significant impact on how buildings and building systems are designed, operated, and maintained. The sponsoring Technical Committees, TC 4.6 and TC 1.4, have to date only superficially addressed some of the issues described above since most lie outside their major areas of interest. By creating a new Task Group that is concerned with smart buildings and smart building systems, ASHRAE will allow a focused effort on this important and rapidly developing field.

This will place ASHRAE in a lead role of defining and shaping the nature of a new generation of buildings and building systems for the 21st century.

TG4.SBS Long-Range Research Plan (Attachment C)

Task Group 4.SBS, Smart Building Systems
Draft Research Project Description
Priority 1

Project Title: Integrated Building Services - Performance and Performance Measures

Summary:
The integration of the control of multiple building services, such as HVAC, fire, security, and transportation, offers the building owners and operators many benefits and some possible problems. Unfortunately there have been no systematic research to evaluate and document the pro and cons of integration, nor to examine the different methods by which it may be achieved. This study will examine different levels of integration in commercial office buildings, including no integration, the use of a single network by different building systems (token integration), full integration using a building management system from a single vendor, and different vendor supplied building systems using a common communication protocol, such as BACnet. The benefits and problems associated with each approach will be carefully documented. In addition, various performance measures will be developed to compare the safety, reliability, comfort, cost, energy consumption, ease of use, maintenance requirements, etc. of the different approaches.

Objective:
To examine different approaches to the integration of building services in a variety of commercial office buildings.

To evaluate and document the pros and cons associated with each approach.

To develop performance measures that can be used by building designers, owners, and operators for comparing different levels of integration and for selecting the best approach for a given application.

To develop recommendations for future research in this area.

Benefits:
This research will provide valuable information on the benefits and problems associated with the integration of building services. The development of performance measures for comparing different approaches should significantly improve the decision making process for building designers, owners, and operators. In addition, this work is likely to lead to the future development of ASHRAE Guidelines on evaluating and choosing the best approach to integrating building services in different applications.

Estimated Cost: $80K Estimated Duration: 12 months

Methods of Publishing Research Results:
1. Detailed Reports
2. Technical Paper(s)

Potential Cosponsors:

Project Title: Methods For The Real-Time Detection and Diagnosis Of Centrifugal Chillers Faults

Summary:

A significant fraction of the energy used in commercial buildings goes to operate centrifugal chillers. Poor performance of these chillers can lead to increased energy consumption, expensive maintenance bills, and unscheduled down time. Current fault detection and diagnostic (FDD) systems focus on preventing catastrophic failures by shutting defective chillers down. Research is needed to develop methods for monitoring thermal performance of centrifugal chillers and for detecting faults that degrade performance over time. The work will consist of a literature search, identifying faults that affect chiller performance, developing a centrifugal chiller simulation model suitable for evaluating different methods for detecting and diagnosing chiller faults in real-time, developing performance indices for quantifying chiller thermal performance, and laboratory and/or field studies to determine which FDD methods work best in actual applications.

Objective:

To identify faults that degrade centrifugal chiller performance.

To develop a suitable centrifugal chiller simulation model and to use the model to develop and evaluate different methods for monitoring chiller performance and for detecting and diagnosing chiller degradation faults in real time.

To evaluate the actual performance of the different FDD methods on a real centrifugal chiller located in the laboratory and/or a real building.

Benefits: Reliable fault detection and diagnostic methods for centrifugal chillers will save energy and significantly reduce operating and maintenance costs for air conditioning commercial buildings.

Estimated Cost: $120K Estimated Duration: 18 months

Methods of Publishing Research Results:

1. Detailed Reports
2. Technical Paper(s)

Potential Cosponsors:

Task Group 4.SBS, Smart Building Systems
Draft Research Project Description
Priority 3

Project Title: Distributed And Hierarchical Fault Detection and Diagnosis of HVAC Systems

Summary:
A variety of different fault detection and diagnostic (FDD) methods have been studied (by IEA Annex 25 and others) and applied to HVAC systems using either simulation or laboratory test rigs. It was found that each of the methods appear to have different strengths and weaknesses. Thus, future FDD systems installed in actual buildings are likely to employ a number of different FDD methods on the same HVAC subsystem, different HVAC subsystems, and at different levels within a building s energy management and control system (EMCS). How the results from all these different FDD applications are coordinated, integrated, evaluated, and how conflicts are resolved and information presented to the operator in an intelligent manner needs to be addressed. This research will attempt to do this for an VAV distribution system (excluding the heating/cooling plant) in a typical office building employing a distributed EMCS.

Objective:
Select 7 or more promising methods for performing FDD on an VAV distribution system using a distributed EMCS in a typical office building.

Examine different approaches for applying these multiple methods to the same and different subsystems and at different control levels within the EMCS.

Examine different approaches for coordinating, integrating, evaluating, and presenting the resulting information to the building operator.

Select several of the most promising FDD system architectures and implement them sequentially in a typical office building that has been approved by the Project Monitoring Committee.

Evaluate and document the benefits and problems associated with each approach and recommend one or more preferred distributed/hierarchical FDD architectures for use in office building HVAC applications.

Benefits: A better understanding of the different approaches for integrating FDD methods in a distributed and hierarchical manner will accelerate the development and implementation of FDD systems in buildings. This in turn should lead to improved HVAC performance, reduced energy consumption, and lower operating and maintenance costs.

Estimated Cost: $120K Estimated Duration: 16 months

Methods of Publishing Research Results:

1. Detailed Reports
2. Technical Paper(s)

Potential Cosponsors:

Task Group 4.SBS, Smart Building Systems
Draft Research Project Description
Priority 4

Project Title: Optimizing EMCS Architecture In BACnet Speaking Systems

Summary:
BACnet - A Data Communication Protocol for Building Automation and Control Networks (ASHRAE Standard 135-1995) was approved by ASHRAE in June 1995 and by ANSI in December 1995. To date, several hundred BACnet speaking EMCS have been installed around the world and the pace of such installations is expected to accelerate rapidly as more and more BACnet products become available. The BACnet standard is extremely flexible and allows the EMSC designer to specify different levels of functionality for different control devices. While this flexibility is in general good, it can cause problems when using BACnet to integrate control system components from different manufacturers. If different control manufactures take different approaches to the distribution of these communication functions among the various levels within an EMCS, it could impact how well control devices at the same (or different) levels can work together. In addition, important issues relating to how different EMCS architectures effect network message traffic, security, and the performance of the building/HVAC/control system need to be addressed.

Objective:
Select several commercial buildings with BACnet speaking EMCS that employ a variety of different EMCS architectures and different approaches to distributing intelligence (functionality) among sensors, unitary controllers, field panels, and work stations.

Evaluate the pros and cons of each architecture from the point of view of network message traffic and response time, security and access, reliability and stand alone capability, control system performance, ease of expansion, software development and maintenance, etc.

Document the results of the above work and recommend one or more standard architectures for BACnet speaking EMCS that optimize most or all of the above performance measures. If a variety of solutions existing depending on application, provide guidelines for designers that will assure proper EMCS performance while minimizing control system interfacing and expansion problems.

Benefits:
It is important to the building industry and to ASHRAE to have the BACnet Communication Protocol adopted and implemented in both new and old EMCS.. This research will help assure that BACnet speaking control system components from different manufacturers will be able to interface at all control levels with optimal performance and a minimum number of problems.

Estimated Cost: $70K Estimated Duration: 12 months

Methods of Publishing Research Results:

1. Detailed Reports
2. Technical Paper(s)

Potential Cosponsors:

Task Group 4.SBS, Smart Building Systems
Draft Research Project Description
Priority 5

Project Title: Utility/EMCS Communication Protocol Requirements

Summary: The key to the development of any communication protocol is first determining the nature of the information that needs to be exchanged. For example BACnet (ASHRAE/ANSI Standard 135-1995) defines standard objects with various properties that provide a network view of building control devices. It also provides various services that can be used to manipulate these objects and properties. The same thing needs to be done for communications between the utility and the EMCS in typical building applications. The type and nature of the information that an EMCS wants to receive from a utility (e.g., real time prices, availability of electricity, time to recovery in case of a power outage, etc.) and the type and nature of information an utility might like to receive from an EMCS (e.g., current load, expected future load, demand limiting capability, status of charge of thermal storage system (if applicable), equipment available for load shedding, etc.) need to be determined in a systematic manner. Obviously, the type of information depends on the type of building (office, retail, light mass, heavy mass, large, small, etc.), the type of HVAC system (with or without a thermal storage system, size of thermal storage system relative to maximum load, etc.), and the nature of the services expected (real-time purchase of electricity from different suppliers, remote energy management and control, fault detection and diagnostics, etc.). This research should evaluate the information exchange requirements between utilities and different types of building/HVAC/control systems and develop a list of standard objects and properties that can be used to describe this information. It should also identify services that can be used to manipulate and exchange this information and identify other issues, such as reliability, security, response time, and user verification, that need to be addressed in real applications.

Objective:
Perform a literature search for information to be exchange between utilities and building EMCS and the status of various protocols that impact the exchange of this information.
For various building/HVAC systems, determine the type and nature of information that needs to be exchanged for each type of possible service or application.
Develop and document standard objects , properties , and services needed to describe, manipulate, and exchange this information between the utility and the EMCS.
Identify, describe, and propose solutions for other issues (such as described in the Summary above) that need to be addressed. Document all of the above work and make recommendations on what ASHRAE role should be in this area and (if appropriate) how ASHRAE should proceed.

Benefits: The exchange of information between utilities and building EMCS will lead to new types of services and benefits (and headaches) for building owners and operators that can not even be imagined today. Just as the Internet, E-mail, and the World Wide Web has changed how we obtain and exchange information, this work will effect how building are operated and at what cost and from whom energy is purchased.

Estimated Cost: $80K Estimated Duration: 12 months

Methods of Publishing Research Results: 1. Detailed Reports 2. Technical Paper(s)

Potential Cosponsors:

Contact Information (to be completed as information is provided by those listed)

Name	Organization
Osman Ahmed	Landis & Gyr
Mark Bailey	US DOE
Nebil Ben-Aissa	Johnson Controls
Steve Blanc	PG&E
Mike Brambley	PNNL
Jim Braun	Purdue University
Barry Bridges	University of Minnesota
Jim Butler	Cimetrics
Jim Coogan	Landis & Gyr
Harsha Dabholkar	Honeywell
Mike DeNamur	Trane Co.
Arthur Dexter	University of Oxford
Rad Ganesh	Trane Co.
Ira Goldschmidt	RNL Facilities Corp.
Rich Hackner	Energy Center of Wisc.
J. Carlos Haiad	Soouthern Cal Edison
Hank Harrington	Simplex
Phil Haves	Loughborough University
Larry Henson	Arizona Public Service Co.
Winston Hetherington	PWGS Canada
Alan Hill	Carrier
John House	NIST
David Kahn	RMH Group
Ron Kammerud	Paradigm Consulting
George Kelly	NIST
Michael Kinter-Meyer	SAIC
Mike Kovacs	HyCal
Jean Lebrun	University of Liege
Carol Lomonaco	Johnson Controls
John Mitchell	University of Wisconsin
Clay Nesler	Johnson Controls
Cher Nicastro	Energy Simulation Spec.
Doug Nordham	Xenergy
Les Norford	MIT
Patrick O'Neill	Honeywell
Ofer Pittel	Rose Technology Group
Kathie Radke	Honeywell
Tim Ruchti	Johnson Controls
William Savery	Portland State University
John Seem	Johnson Controls
Gideon Shavit	Honeywell
Patrick Sheridan	Simplex
Peter Simmonds	Flack + Kurtz
Gene Strehlow	Johnson Controls
Terry Townsend	Townsend Engr.
Larry Uebele	Honeywell
David Underwood	US Army CERL
Verle WIlliams	Verle A. WIlliams & Assoc.
Jim Winston	RMH Group
Bob Zamojcin	Carrier